

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference PHGB040044	FOR FURTHER ACTION	See item 4 below
International application No. PCT/IB2005/050595	International filing date (<i>day/month/year</i>) 17 February 2005 (17.02.2005)	Priority date (<i>day/month/year</i>) 21 February 2004 (21.02.2004)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant KONINKLIJKE PHILIPS ELECTRONICS N.V.		

1.	This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 <i>bis</i> .1(a).																								
2.	<p>This REPORT consists of a total of 7 sheets, including this cover sheet.</p> <p>In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.</p>																								
3.	<p>This report contains indications relating to the following items:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 10%; text-align: center;"><input checked="" type="checkbox"/></td> <td style="width: 30%;">Box No. I</td> <td style="width: 60%;">Basis of the report</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td>Box No. II</td> <td>Priority</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td>Box No. III</td> <td>Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td>Box No. IV</td> <td>Lack of unity of invention</td> </tr> <tr> <td style="text-align: center;"><input checked="" type="checkbox"/></td> <td>Box No. V</td> <td>Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td>Box No. VI</td> <td>Certain documents cited</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td>Box No. VII</td> <td>Certain defects in the international application</td> </tr> <tr> <td style="text-align: center;"><input type="checkbox"/></td> <td>Box No. VIII</td> <td>Certain observations on the international application</td> </tr> </table>	<input checked="" type="checkbox"/>	Box No. I	Basis of the report	<input type="checkbox"/>	Box No. II	Priority	<input type="checkbox"/>	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability	<input type="checkbox"/>	Box No. IV	Lack of unity of invention	<input checked="" type="checkbox"/>	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement	<input type="checkbox"/>	Box No. VI	Certain documents cited	<input type="checkbox"/>	Box No. VII	Certain defects in the international application	<input type="checkbox"/>	Box No. VIII	Certain observations on the international application
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4.	The International Bureau will communicate this report to designated Offices in accordance with Rules 44 <i>bis</i> .3(c) and 93 <i>bis</i> .1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44 <i>bis</i> .2).																								

<p style="text-align: center;">The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No. +41 22 338 82 70</p>	<p>Date of issuance of this report 22 August 2006 (22.08.2006)</p> <p>Authorized officer</p> <p style="text-align: center; font-size: 1.2em;">Cecile Chatel</p> <p>e-mail: pt13@wipo.int</p>
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PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

REC'D 23 AUG 2005

PCT PCT

To:

see form PCT/ISA/220

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/IB2005/050595

International filing date (day/month/year)
17.02.2005

Priority date (day/month/year)
21.02.2004

International Patent Classification (IPC) or both national classification and IPC
H01L29/78, H01L29/10, H01L21/336, H01L29/423

Applicant
KONINKLIJKE PHILIPS ELECTRONICS N.V.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA"). However, this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of three months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:



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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/IB2005/050595

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
☐ This opinion has been established on the basis of a translation from the original language into the following language , which is the language of a translation furnished for the purposes of international search (under Rules 12.3 and 23.1(b)).
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
☐ a sequence listing
☐ table(s) related to the sequence listing
 - b. format of material:
☐ in written format
☐ in computer readable form
 - c. time of filing/furnishing:
☐ contained in the international application as filed.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority for the purposes of search.
3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**

International application No.
PCT/IB2005/050595

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	4-7
	No: Claims	1-3,8
Inventive step (IS)	Yes: Claims	4-7
	No: Claims	1-3,8
Industrial applicability (IA)	Yes: Claims	1-8
	No: Claims	

2. Citations and explanations

see separate sheet

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1. Reference is made to the following documents:
D1: WO-A-03/088364
D2: PATENT ABSTRACTS OF JAPAN vol. 2000, no. 16 & JP-A-2001024193
2. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1, 2, 3 and 8 is not new in the sense of Article 33(2) PCT.
- 2.1 The document D1 discloses (see D1: figs. 1, 2 and page 10, line 30 - page 11, line 17, the references in parentheses applying to this document) a vertical trench-gate semiconductor device comprising a semiconductor body (20) and a plurality of trenches (11) with insulated gate electrodes extending in it; the semiconductor body comprising source and drain regions (13,12) in it separated by a channel accommodating region (14), wherein the trenches extend in stripes, the source regions extend in stripe transversally between the trenches, and mutually spaced regions of the second conductivity type (the portions of the regions (15) located below the trench bottom; see in particular also D1: page 11, lines 7-11) are provided below the trench portions between the projected source stripes, these regions being connected to the source potential (see in particular also D1: page 11, lines 11-17).

Therefore, the subject-matter of claims 1, 2 and 3 is not new.

- 2.2 Furthermore, D1 discloses (see D1: figs. 1, 2 and page 10, line 30 - page 11, line 17) also a method of manufacturing the vertical trench-gate transistor of above, comprising the step of forming a mask over the top surface of the semiconductor body and introducing dopant of the second conductivity type through the windows of the mask for the spaced regions (15) (see in particular see D1: page 11, lines 28-31).

Therefore, also the subject-matter of corresponding method claim 8 is not new.

3. The combination of the features of dependent claims 4-7 is neither known from, nor

rendered obvious by, the available prior art. The reasons are as follows:

Cited document D1 shows a vertical trench-gate semiconductor device with n-type source and p-type regions extending as stripes perpendicular to the trenches, wherein the trenches have an uniform depth.

The subject-matter of claim 4 differs from this known device in that the depth of the trenches changes (i.e. the trenches become shallower) in portions where no source is present, in such a way as to make the trenches not extending in the drain region in those portions; i.e. in the inactive regions, where no conduction channel can be formed, the trench are shallower and confined in the channel accommodating region.

The subject-matter of claim 4 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as how to reduce the switching time by decreasing the gate to drain capacitance C_{gd} of a trench gated semiconductor device with a stripe-like layout for source and body regions.

The solution to this problem proposed in claim 4 of the present application is considered as involving an inventive step (Article 33(3) PCT) because, due to a proper structuring of the trench depth, the channel accommodating region itself, without the necessity of an additional implantation (as done in D1), selectively shield portions of the trench-gate from the drain, thus suppressing their contribution to the gate to drain capacitance C_{gd} .

Further cited document D2 shows a vertical trench-gate semiconductor device with trenches of different depths. In particular, D2 shows a gate lead-out trench in a peripheral area, which is made shallower than the trenches in the MOS section (i.e. the section including a channel accommodating region) and which extend in, but not through, a shallow p-well in contact with the body p-well. In this way concentration of electric fields on the bottom of a gate lead-out trench is prevented.

The subject-matter of claim 4 differs from this known device in that the trenches are oscillating in their depths along their length and a stripe-layout perpendicular to the trenches for source and body regions is formed with the body regions being then

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING
AUTHORITY (SEPARATE SHEET)**

International application No.

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located below the trenches in their shallower portions.

Therefore, the device proposed in claim 4 of the present application is neither disclosed nor suggested by the available prior art and has the advantages of reducing the Cgd of a stripe-like trench gate structure, without the necessity of complicated structuring for manufacturing it.

Claims 5-7 are dependent on claim 4 and as such also meet the requirements of the PCT with respect to novelty and inventive step.